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AFPTEF PROJECT NO. 09-P-103

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Performance Testing of the Hardigg M-9 Weapons Case

AFMC 403 SCMS / GUEB
AIR FORCE PACKAGING TECHNOLOGY & ENGINEERING FACILITY
WRIGHT PATTERSON AFB, OH 45433-5540
20 Feb 2009

NOTICE

AFPTEF PROJECT NO. 09-P-103
TITLE: Performance Testing of the Hardigg M-9 Weapons Case

ABSTRACT

The Air Force Packaging Technology Engineering Facility (AFPTEF) carried out performance testing of the Hardigg M-9 weapons case, at the request of the 66 MSG/LRDS at Hanscom AFB, MA. Tests were conducted in accordance with ASTM D4169, DC-18 for assurance level I, and in accordance with MIL-STD-648C.

The weapons case did not pass the initial leak check, and therefore cannot protect the items from exposure to humidity. Additionally, there were slight permanent deformations: bowing-out at the ends of the case due to hot/cold handle pull tests, and bowing of the loaded handle due to the hot handle pull test. However, these deformations do not affect the ability of the case to secure the items and provide adequate physical protection. Sealing each weapon in a separate water-vapor-proof barrier bag prior to storage in the case will provide adequate environmental protection.

Total man-hours: 33

TEST ENGINEER:
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Mechanical Engineer
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INTRODUCTION

BACKGROUND – The 66 MSG/LRDS (Hanscom AFB) requested a waiver to use Hardigg cases for shipment and storage of its M9 pistols. The Air Force Packaging Technology and Engineering Facility (AFPTEF) needed to test and approve these cases prior to their inclusion in the Special Packaging Instruction.

REQUIREMENTS – The Hardigg case must be capable of protecting M9 pistols from the effects of direct exposure to extremes of climate, terrain, and operational and transportation environments.

DESIGN – The Hardigg M9 case (Appendix 2, Figure 1a) consists of a rotational molded, gasketed polyethylene clamshell with custom-cut polyethylene foam on the inside. External hardware includes 3 stainless steel hinges, 5 half-turn latches, two plastic handles, a pressure relief valve, and a humidity indicator. Foam cutouts will accommodate 10 M9 pistols with 10 spare magazines.

QUALIFICATION TESTING

TEST SAMPLE – The 66 MSG/LRDS supplied AFPTEF with two empty sample cases for testing, one with a humidity indicator and one without. The weight of the cases was 25 lb empty and 46 lb loaded. External dimensions were 26.5 (length) in x 19 in (width) x 13.5 in (height). Each face of the weapons case was uniquely identified for testing purposes. Table 1 defines these six faces, in addition to edges and corners that are referenced within the test plan and the remainder of the test report. See Appendix 2, Figure 1b for an illustration of edge and corner locations on the case.

Table 1. Weapons Case Orientation.

Designated Face / Edge / Corner	Container Feature
TOP	TOP
BOTTOM	BOTTOM
FRONT (FWD)	Pressure Relief Valve
BACK (AFT)	Hinges
LEFT	Left Handle, Forward-Looking-Aft (FLA)
RIGHT	Right Handle, FLA
EDGE 1 (BOTTOM)	BOTTOM-LEFT Edge
EDGE 2 (BOTTOM)	BOTTOM-FRONT Edge
EDGE 3 (VERTICAL)	FRONT-RIGHT Edge
EDGE 4 (TOP)	TOP-AFT Edge
EDGE 5 (VERTICAL)	FRONT-LEFT Edge
EDGE 6 (VERTICAL)	BACK-RIGHT Edge (Opposite Edge 5)
CORNER 1 (BOTTOM)	BOTTOM-LEFT-AFT Corner
CORNER 2 (BOTTOM)	BOTTOM-RIGHT-FWD Corner
CORNER 3 (TOP)	TOP-RIGHT-AFT Corner

TEST LOAD – AFPTEF fabricated 10 dummy-load M9 pistols for testing (See Appendix 2, Figure 13), using aluminum alloy block with a thickness of 1.375 inches. The combined weight of the dummy pistols was 20.7 lb, which was within 1.5% of the target weight of 21.0 lb.

TEST PLAN – The primary references for the test plan were ASTM D 4169, DC 18, and MIL-STD-648C (Appendix 1). The methods specified in the test plan determined the procedure for testing of the cases. The pass/fail criteria for evaluation of the cases were specified as no damage, deformation or degradation of the container or components that would permit damage to contents, prevent installation of components, reduce container strength or cause stacking instability, permit water to enter, adversely affect safety during transport or storage, or interfere with container use. All components shall remain in place throughout testing. The tests were performed at AFPTEF, Building 70, Area C, Wright-Patterson AFB.

ITEM INSTRUMENTATION – No data recording instrumentation was used in the testing below. See Appendix 4 for other test instrumentation information.

TEST SEQUENCES

TEST SEQUENCE 1 – Initial Leak Test

Procedure – The breather valve was removed and replaced with a flanged fitting modified for attachment of the digital manometer and vacuum/pressure pump lines. The container was closed and latches tightened. The pneumatic pressure leak technique was used to pressurize the container to a minimum test pressure of 0.5 psi (Appendix 2, Figure 2). Maximum allowable leak rate is 0.05 psi per hour. The leak test was conducted at ambient temperature and pressure.

Results – Fail: The first container failed the leak test with a leak rate in excess 0.05 psi *per minute*. The second container failed the leak test with a leak rate of approximately 0.10 psi per hour. Leaks were found *around the entire perimeter* of both cases. Note the indentations found on the gasket surface at room temperature (Appendix 2, Figure 3a and 3b). From a design standpoint, the gasket material and/or the number of latches is inadequate for this case.

Note: The sample cases have been in service for 2-3 years. Therefore, if brand new cases provide a satisfactory level of water-vapor-proof protection, it will not last for more than 2-3 years.

TEST SEQUENCE 2 – Handle Strength Test, Hot

Procedure: The case was suspended from one of the handles for 1 hour at a temperature of 160^{o}F (Appendix 2, Figure 4).

Results: Pass: There was a significant amount of deformation to the handle immediately after the test (Appendix 2, Figure 5). After 24 hours, a lesser amount

of *permanent* deformation remained (Appendix 2, Figure 6), but the handle is still functional. When raised and lowered slowly, the handle sticks and does not drop freely to the side of the case (Appendix 2, Figure 7). If it is raised and released, there is enough spring force to return the handle to the side of the case.

There was also a slight bowing-out of the left end of the case (Appendix 2, Figure 17) due to this test. This will not affect the ability of the case to protect the items. However, if the case had passed the initial leak check, this deformation may have diminished the sealing properties of the case.

TEST SEQUENCE 3 – Handle Strength Test, Cold

Procedure – The case was suspended from the opposite handle for 1 hour at a temperature of -50°F (Appendix 2, Figure 8).

Results – Pass: The handle deformed *temporarily* to the point that, when released, it did not drop freely to the side of the case. Within 24 hours the handle returned to the original shape.

There was also a slight bowing-out of the right end of the case (Appendix 2, Figure 18) due to this test. This will not affect the ability of the case to protect the items. As with Test Sequence 2, if the case had passed the initial leak check, this deformation may have diminished the sealing properties of the case.

TEST SEQUENCE 4 – Freefall Drops, Cold

Procedure – The case was conditioned for 24 hours at a temperature of -40°F, and then dropped six times from a height of 24 inches (Appendix 2, Figure 9). Impact locations were as follows:

1. Top Face
2. Edge 1
3. Edge 2
4. Corner 1
5. Corner 2
6. Bottom Face

Results – Pass: The impacts caused no visible damage to either the container or the items. There were slight indentations to the case from resting on the edge of the drop testing platform.

TEST SEQUENCE 5 – Freefall Drops, Hot

Procedure – The case was conditioned for 24 hours at a temperature of 140°F, and then dropped from a height of 24 inches (Appendix 2, Figure 10). Impact locations were as follows:

1. Edge 3
2. Right Face
3. Front Face
4. Corner 3
5. Edge 4
6. Bottom Face

Results – Pass: The impacts caused no visible damage to either the container or the items. There were slight indentations to the case from resting on the edge of the drop testing platform (Appendix 2, Figure 11). Items also shifted around in the case (Appendix 2, Figure 12), due to softness of the foam at high temperatures and the shape of the dummy items (Appendix 2, Figure 13). However, the trigger portion of a real M9 rests in the foam such that it prevents the item from sliding around in the case.

TEST SEQUENCE 6 – Loose-Load Vibration Test, Repetitive Shock

Procedure – A sheet of 3/4-inch plywood was bolted to the top of the vibration table, and the container was placed on the plywood. Restraints were used to prevent the container from sliding off the table. The container was allowed approximately 1/2-inch unrestricted movement in the horizontal direction from the centered position on the table (Appendix 2, Figure 14).

The table frequency was increased from 3.5 Hz until the container left the table surface (approximately 4.0 Hz). At one-inch double amplitude, a 1/16-inch-thick flat metal feeler could be slid freely between the table top and the container under all points of the container. Repetitive shock testing was conducted for 2 hours at ambient temperature.

Results – Pass: The loaded container was vibrated at 4.0 Hz for 2 hours. At the end of testing there was no visible damage to the either the container or the item.

TEST SEQUENCE 7 – Warehouse Stacking

Procedure – A 250-pound static load, consisting of the spare weapons case (#1 from leak test), a sheet of plywood, and iron weights, was set on top of the test case (Appendix 2, Figure 15). The stacked configuration was placed in an environment at 140^{o}F and 90% relative humidity for 24 hours. The chamber was shut down, with the stacked configuration remaining in the closed chamber for 6 more days. Although test time was shortened from 168 hours as specified in the test plan, 24 hours at the test point (140^{o}F and 90% RH) is sufficient to expose structural weakness of the container.

Results – Pass: There was no visible damage to the either the container or the item.

TEST SEQUENCE 8 – Wind and Rain Exposure

Procedure – As a follow-on to the failed leak test, AFPTEF wanted to demonstrate that the case would protect items from rain. The weapons case was placed in a rain chamber and subjected to 5 in/hour rainfall with 40-mph wind for a total of 90 minutes (Appendix 2, Figure 16). The case sat in two different orientations, with edges 5 and 6 facing into the wind for 45 minutes each.

Results – Pass: There were no signs of water intrusion into the case.

TEST CONCLUSIONS – Aside from apparent degradation of the gasket that prevented the case from sealing, there was no other damage, deformation or degradation of the case or components that would permit physical or rain-water damage to the items, reduce case strength, adversely affect safety during transport or storage, or interfere with manual handling or use of the case.

CONCLUSIONS & RECOMMENDATIONS

Although the Hardigg M9 weapons case failed to achieve an adequate water-vapor-proof seal, the case satisfied the remaining performance test requirements for level A packaging. During testing, the case secured the items and protected them from physical damage and rain intrusion. For corrosion protection of the items during worldwide shipping and storage, AFPTEF recommends sealing each weapon in a separate water-vapor-proof barrier bag prior to storage in the case.

APPENDICES

APPENDIX 1: Test Plan

AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY (Container Test Plan)					**AFPTEF PROJECT NUMBER:** 09-P-103	
CONTAINER SIZE (L x W x D) (IN) **INTERIOR:**	**EXTERIOR:**	**WEIGHT (LB)** **GROSS:**	**TARE**	**CUBE (CU. FT)**	**QUANTITY:**	**DATE:**
N/A	26.5 x 19 x 13.5	41	20	4.2	1	Jan 09
ITEM NAME: (10) M-9s				**MANUFACTURER:** Hardigg		
CONTAINER NAME: Hardigg 472-M9-10-S					**CONTAINER COST:**	
PACK DESCRIPTION: (10) M-9s						
CONDITIONING: Ambient, 160°F, 140°F / 95% RH, -65°F, -40°F						

TEST NO.	**REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S**	**TEST TITLE AND PARAMETERS**	**CONTAINER ORIENTATION**	**INSTRU-MENTATION**
		PASS/FAIL CRITERIA FOR ALL TESTS There shall be no damage, deformation or degradation of the container or components that would permit damage to contents, prevent installation of components, reduce container strength or cause stacking instability, permit water to enter, adversely affect safety during transport or storage, interfere with container use. All components shall remain in place throughout testing.		
1.	**Product examination.**	Fully assembled container shall be weighed, measured, and all components, assembly and closure requirements examined for accordance with manufacturer instructions and documentation.	Ambient temp.	Visual Inspection (VI), tape measure; Scale
		Weight Test.	Ambient temp.	Scale
2.	**Leak Check** **MIL-STD-648D Para 5.6.2**	An initial leak test shall be performed prior to testing, and then performed after each test sequence to verify leakage integrity of the container. Pneumatic-pressure technique shall be used with a test pressure of 0.5 psig. Pressure loss shall not exceed 0.05 psi in 1 hour.	Ambient temp.	Air pump, valves, fittings, digital manometer, and clock
3.	**Handle Strength Test, HOT** **MIL-STD-648D Para 5.8.5**	Container shall be suspended for a duration of 1 hour from handle, at a temperature of 160°F .	Left Handle	Environmental chamber, hanging fixture

COMMENTS:	
PREPARED BY: Michael R. Harff, Mechanical Engineer	**APPROVED BY:** Robbin L. Miller, Chief AFPTEF

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AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY (Container Test Plan)					**AFPTEF PROJECT NUMBER:** 09-P-103	
CONTAINER SIZE (L x W x D) (IN) **INTERIOR:**	**EXTERIOR:**	**WEIGHT (LB)** **GROSS:**	**ITEM:**	**CUBE (CU. FT)**	**QUANTITY:**	**DATE:**
N/A	26.5 x 19 x 13.5	41	20	4.2	1	Jan 09
ITEM NAME: (10) M-9s				**MANUFACTURER:** Hardigg		
CONTAINER NAME: Hardigg 472-M9-10-S					**CONTAINER COST:**	
PACK DESCRIPTION: (10) M-9s						
CONDITIONING: Ambient, 160°F, 140°F / 95% RH, -65°F, -40°F						

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	EQUIPMENT & INSTRUMENTATION
4.	**Handle Strength Test, COLD** **MIL-STD-648D Para 5.8.5**	Container shall be suspended for a duration of 1 hour from handle, at a temperature of -65°F.	Right Handle	Environmental chamber, hanging fixture
5.	**Freefall Drops, COLD** **ASTM D4169-08, A1.2.1, Assurance Level 1. ASTM D5276**	Container shall be conditioned for up to 24 hours at -40°F, and then First Sequence of drops shall be performed with a drop height of 24 inches. All drops shall be performed within 10 minutes of removal from environmental chamber. Otherwise, container shall be placed in chamber for 1 hour prior to retesting.	1. Top 2. Edge #1 3. Edge #2 4. Corner #1 5. Corner #2 6. Bottom	Environmental chamber, drop tester, tape measure
6.	**Freefall Drops, HOT** **ASTM D4169-08, A1.2.1, Assurance Level 1. ASTM D5276**	Container shall be conditioned for up to 24 hours at 140°F, and then Second Sequence of drops shall be performed with a drop height of 24 inches. All drops shall be performed within 10 minutes of removal from environmental chamber. Otherwise, container shall be placed in chamber for 1 hour prior to retesting.	1. Edge #3 2. Right Face 3. Front Face 4. Corner #3 5. Edge #4 6. Bottom	Environmental chamber, drop tester, tape measure
7.	**Loose Load Vibration Test** **ASTM D4169-08, A1.6, Assurance Level 1. ASTM D999, Method A1**	Container with test load shall be tested as described with a dwell time of 2 hours, in one position.	Ambient	Vibration table, controller

COMMENTS:

PREPARED BY:	**APPROVED BY:**
Michael R. Harff, Mechanical Engineer	Robbin L. Miller, Chief AFPTEF

AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY (Container Test Plan)					**AFPTEF PROJECT NUMBER:** 09-P-103	
CONTAINER SIZE (L x W x D) (IN) **INTERIOR:**	**EXTERIOR:**	**WEIGHT (LB)** **GROSS:**	**ITEM:**	**CUBE (CU. FT)**	**QUANTITY:**	**DATE:**
N/A	26.5 x 19 x 13.5	41	20	4.2	1	Jan 09
ITEM NAME: (10) M-9s				**MANUFACTURER:** Hardigg		
CONTAINER NAME: Hardigg 472-M9-10-S					**CONTAINER COST:**	
PACK DESCRIPTION: (10) M-9s						
CONDITIONING: Ambient, 160°F, 140°F / 95% RH, -65°F, -40°F						

TEST NO.	**REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S**	**TEST TITLE AND PARAMETERS**	**CONTAINER ORIENTATION**	**EQUIPMENT & INSTRUMENTATION**
8.	**Stack Test** **MIL-STD-648D, para. D.6(a)**	An identical container base shall be placed on top of the test container and a stack load shall be placed on that container base, for a total load of 246 lb. Load shall be left in place for 168 hours. Container shall be examined for damage at the end of 168 hours. Load = Mass*(H/h – 1)*FoS: Mass = 41 lb, H/h = 5, FoS (Factor of Safety) = 1.5	140°F / 95% RH	Environmental chamber, iron weights
9.	**Wind and Rain Exposure**	Container shall be placed in rain chamber and subjected to 40-mph wind and rain at 5 in/hour for a total of 1 hour. Container shall be examined for water intrusion at the end of 1 hour.	1. Edge #5 facing into the wind 2. Edge #6 facing into the wind	Rain chamber

COMMENTS:	
PREPARED BY: Michael R. Harff, Mechanical Engineer	**APPROVED BY:** Robbin L. Miller, Chief AFPTEF

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APPENDIX 2: Case and Testing Photographs

Figure 1a. Case with dummy loads inserted.

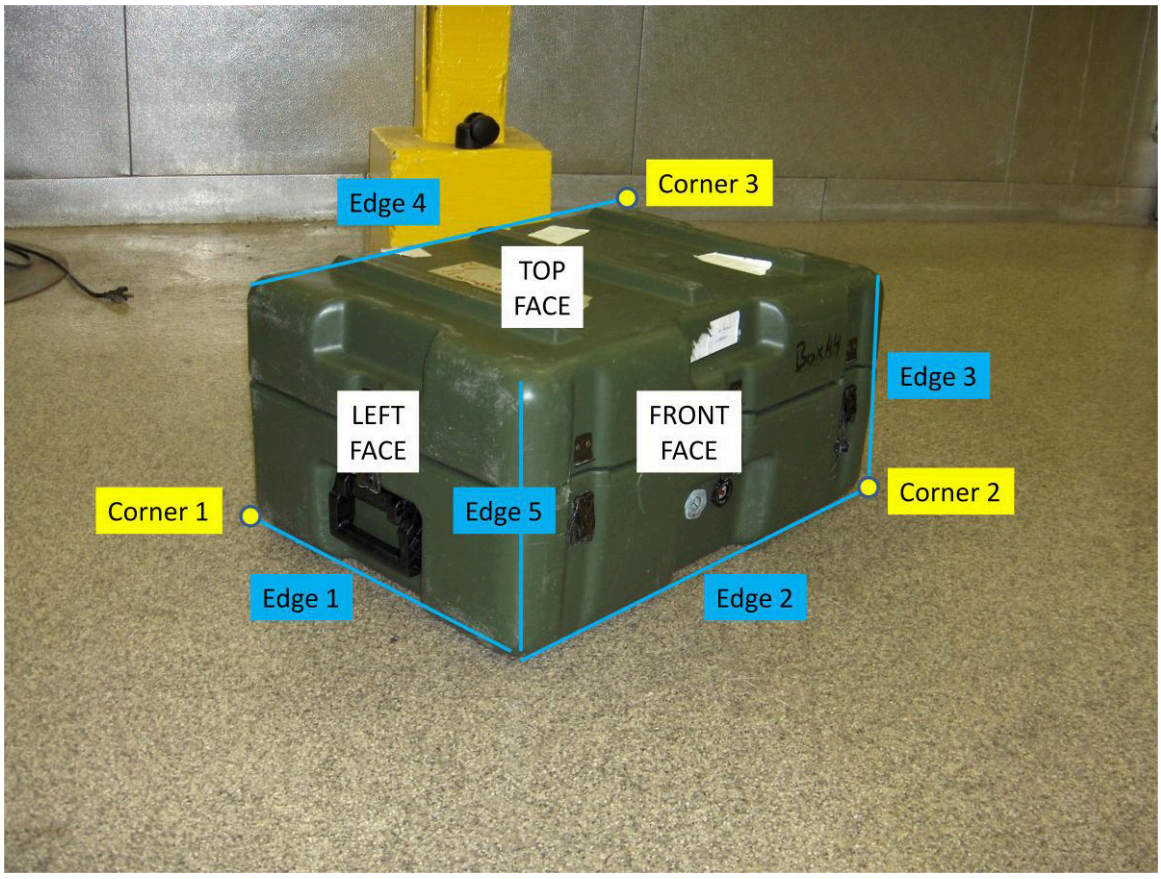

Figure 1b. Edge and Corner Locations for Testing.

Figure 2. Leak test setup for case #2.

Figure 3a. Gasket surface indentation – corner of case.

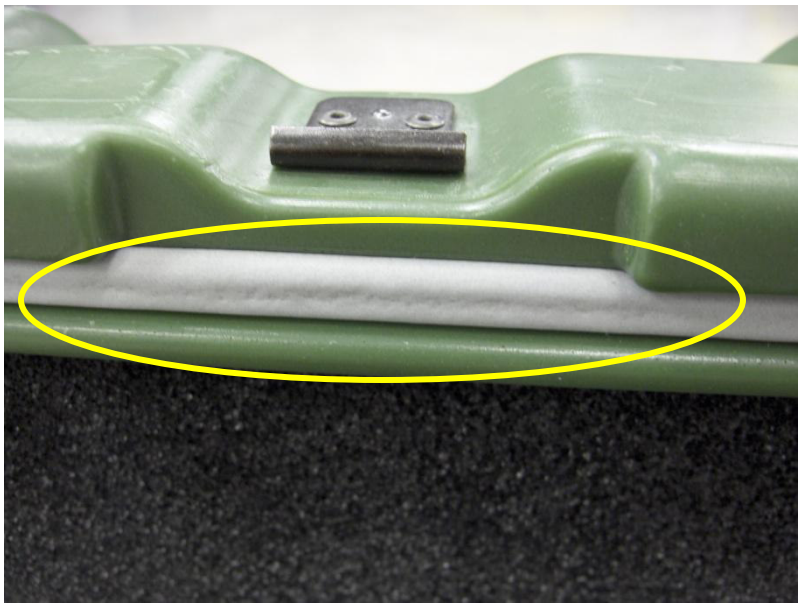

Figure 3b. Gasket surface indentation – side of case.

Figure 4. Handle strength test, hot.

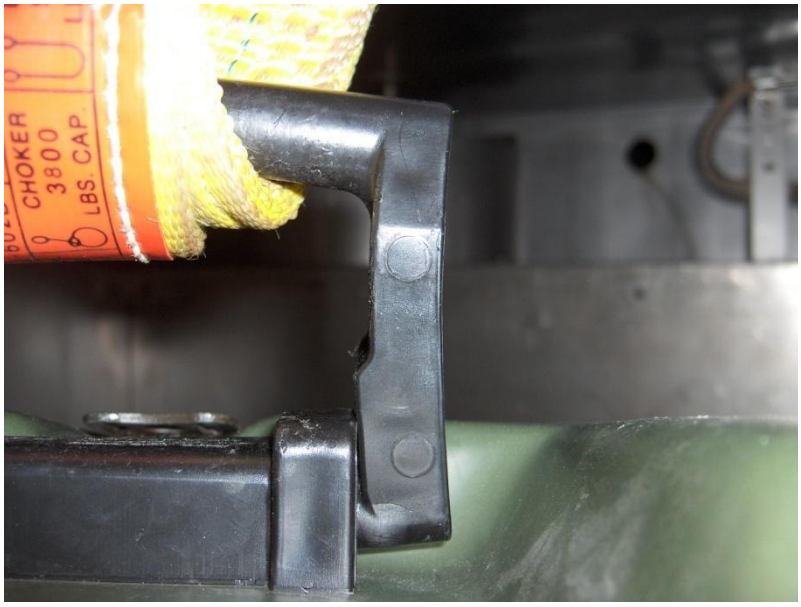

Figure 5. Handle deformation immediately after hot strength test.

Figure 6. Permanent deformation from hot handle strength test (A), and untested handle (B).

Figure 7. Sticking of tested handle.

Figure 8. Handle strength test, cold.

Figure 9. Freefall drop test, cold.

Figure 10. Freefall drop test, hot.

Figure 11. Scratches due to contact with edge of the drop tester.

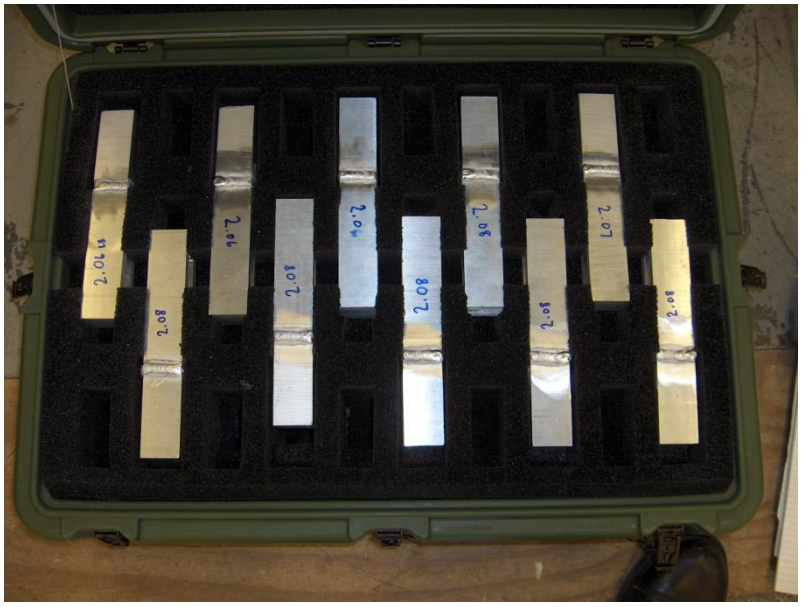

Figure 12. Shifting of items within the case.

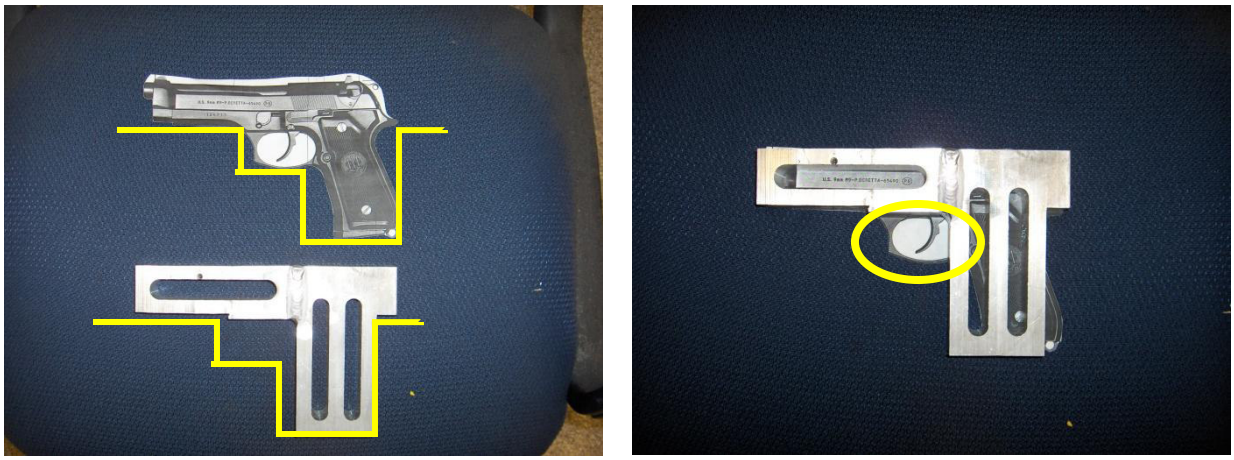

Figure 13. Comparison of (a photograph of) M9 with a dummy item, showing how items fit into foam cutout. Dummy items had no trigger to prevent them from sliding within the case.

Figure 14. Loose load vibration test.

Figure 15. Warehouse stacking test.

Figure 16. Rain chamber test.

Figure 17. Comparison of untested case (A) with tested case (B). Note slight bowing-out of the left end of case B, caused by the hot handle strength test.

Figure 18. Comparison of untested case (A) with tested case (B). Note slight bowing-out of the right end case B, caused by the cold handle strength test.

APPENDIX 3: Test Instrumentation

PRESSURE TEST EQUIPMENT - Test sequence 1

EQUIPMENT	MANUFACTURER	MODEL	SN	CAL. DATE
Digital Manometer	Yokogawa	2655	82DJ6001	Dec 08
Digital Manometer	Yokogawa	2655	82DJ6009	Dec 08

VIBRATION TEST EQUIPMENT - Test sequence 5

EQUIPMENT	MANUFACTURER	MODEL	SN	CAL. DATE
Servohydraulic Vibration Machine	Team Corp.	Special	1988	N/A
Feedback Hardware Controller	Dactron Corp.	PCI DSP Card Front End DSP Box	2208515 4544828	Aug 08 N/A
Feedback Software Controller	Dactron Corp.	Version 2.1	N/A	N/A
Table Feedback Accelerometer	Endevco	2271AM20	103870	Nov 07
Feedback Amplifier	Endevco	2775A	EL65	N/A

APPENDIX 4: Distribution List

DISTRIBUTION LIST

DTIC/O
DEFENSE TECHNICAL INFORMATION CENTER
FORT BELVOIR VA 22060-6218

403 SCMS/CL
5215 THURLOW ST, STE 5
BLDG 70C
WRIGHT-PATTERSON AFB OH 45433-5547

66 MSG/LGS
ATTN WILLIAM PERKINS
29 RANDOLPH RD
BLDG 1102D
HANSCOM AFB, MA 01731

418 SCMS/GULAAA
ATTN THELMA LOOCK
7973 UTILITY DR
BLDG 1135
HILL AFB UT 84056

420 SCMS/GUMAA
ATTN CAROL BAXTER
7701 ARNOLD ST
BLDG 1, RM 112
TINKER AFB OK 73145

406 SCMS/GUMA
ATTN WAYNE OSBORN
375 PERRY ST
BLDG 255
ROBINS AFB GA 31098

575 CBSS/GBLC
ATTN JUNE SIMS
460 RICHARD RAY BLVD STE 221
ROBINS AFB GA 31098

APPENDIX 5: Report Documentation

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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Performance Testing of the Hardigg M9 Weapons Case

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6. AUTHOR(S)
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5d. PROJECT NUMBER
09-P-103

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Packaging Technology & Engineering Facility
403 SCMS / GUEB
5215 Thurlow St, Ste. 5
Wright-Patterson AFB, OH 45433-5547

8. PERFORMING ORGANIZATION REPORT NUMBER
09-R-01

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10. SPONSOR/MONITOR'S ACRONYM(S)

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12. DISTRIBUTION AVAILABILITY STATEMENT A

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The Air Force Packaging Technology Engineering Facility (AFPTEF) carried out performance testing of the Hardigg M-9 weapons case, at the request of the 66 MSG/LRDS at Hanscom AFB, MA. Tests were conducted in accordance with ASTM D4169, DC-18 for assurance level I, and in accordance with MIL-STD-648C.

The weapons case did not pass the initial leak check, and therefore cannot protect the items from exposure to humidity. Additionally, there were slight permanent deformations: bowing-out at the ends of the case due to hot/cold handle pull tests, and bowing of the loaded handle due to the hot handle pull test. However, these deformations do not affect the ability of the case to secure the items and provide adequate physical protection. Sealing each weapon in a separate water-vapor-proof barrier bag prior to storage in the case will provide adequate environmental protection.

15. SUBJECT TERMS
M9, M9 Shipping and Storage, Weapons Case Test, Hardigg Case, Small Weapons Case

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Michael R. Harff
U	U	U	UU	26	**19b. TELEPONE NUMBER (*Include area code*)** (937)257-4519